MASSACHUSETTS 2002 BASELINE

EMISSION INVENTORY OF:

VOLATILE ORGANIC COMPOUNDS
NITROGEN OXIDES
CARBON MONOXIDE
SULFUR DIOXIDE
PARTICULATE MATTER
AMMONIA

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LIST OF ACRONYMS

AAR	Association of American Railroads
ADT	Average Daily Traffic (Volume)
AIM	Associated Industries of MA
BEIS-3	Biogenic Emission Inventory System (Version 3.0)
BTP&D	Bureau of Transportation Planning & Development
BWP	Bureau of Waste Prevention (Department of Environmental Protection)
CAA	Clean Air Act
CAP	Criteria Air Pollutants
CARB	California Air Resources Board
CBP	County Business Patterns -US Dept. of Commerce
CE	Control Efficiency
CEMS	Continuous Emission Monitoring Systems
CERR	Consolidated Emissions Reporting Requirements
CMU	Carnegie Mellon University (Ammonia Emissions)
CO	Carbon Monoxide
CNG	Compressed Natural Gas
CTG	Control Technology Guidelines
CTPS	Central Transportation Planning Staff
DOC	Department of Commerce (US)
DOE	Department of Energy (US)
DOER	Division of Energy Resources (Massachusetts)
EIA	Energy Information Administration (US Department of Energy)
DOT	Department of Transportation (US)
DVMT	Daily Vehicle Miles Traveled
EDMS	Emission & Dispersion Modeling System (FAA Aircraft)
EIA	Energy Information Administration (US DOE)
EIIP	Emission Inventory Improvement Program (EPA)
EI/M	Enhanced Inspection/Maintenance
EOEA	Executive Office of Environmental Affairs (Massachusetts)
EOTC	Executive Office of Transportation and Construction (Massachusetts)
EPA	Environmental Protection Agency (US)
ES	Emission Statement (SSEIS)
FAA	Federal Aviation Administration
FAEED	Federal Aviation Emission Estimation Database
FHWA	Federal Highway Administration
FMVCP	Federal Motor Vehicle Control Program
FR	Federal Register
HAP	Hazardous Air Pollutants
HC	Hydrocarbon
HPMS	Highway Performance Monitoring System
I/M	Inspection and Maintenance Program (Massachusetts)
IWW	Industrial Wastewater
LANDGEM	Landfill Gas Estimation Model
LBSD	Pounds per Summer Day
LEV	Low Emitting Vehicles
LPG	Liquid Petroleum Gas
LTO	Landing and Take-off (cycle)
MANE-VU	Mid Atlantic Northeast Visibility Union
MARAMA	Mid Atlantic Regional Air Management Association

MassDEP	Massachusetts Department of Environmental Protection
MASSPORT	Massachusetts Port Authority
MBTA	Metropolitan Boston Transit Authority
MHD	Massachusetts Highway Department
MISER	Massachusetts Institute for Social and Economic Research
MOBILE6.2	EPA's On-road Mobile Source Emission Factor Model version 6.2
MSW	Municipal Solid Waste
NAAQS	National Ambient Air Quality Standard
NESCAUM	Northeast States for Coordinated Air Use Management
NH3	Ammonia
NON	Notice of Non-Compliance
IPP	Inventory Preparation Plan
NAICS	North American Industrial Code System
NEI	National Emissions Inventory (EPA)
NIF	NEI Input Format
NONROAD	Non-Road Model developed by EPA/OTAQ for off-highway engines
NOx/NO_2	Nitrogen Oxides/Nitrogen Dioxide
OTAQ	Office of Transportation and Air Quality (EPA)
OTC	Ozone Transport Commission
PEI	Periodic Emission Inventory
POTW	Publicly Owned Treatment Works
PM	Particulate Matter (10 and 2.5 microns)
PPM	Parts per million
QA/QC	Quality Assurance/Quality Control
RACT	Reasonable Available Control Technology
RE/RP	Rule Effectiveness/Rule Penetration
RFG	Reformulated Gasoline
RH	Regional Haze
RVP	Reid Vapor Pressure
SCC	Source Classification Code
SIC	Standard Industrial Classification Code
SIP	State Implementation Plan
SO2	Sulfur Dioxide
SSEIS	Stationary Source Emission Inventory System
TDM	Travel Demand Model
TPD	Tons per Day
TPFD	Tons per Fall Day
TPPD	Tons per Spring Day
TPSD	Tons per Summer Day
TPWD	Tons per Winter Day
TPY	Tons per Year
TSDF	Treatment, Storage and Disposal Facilities
USGS	US Geological Survey
UST	Underground Storage Tanks
VMT	Vehicle Miles Travelled
VOC	Volatile Organic Compound

SECTION 1

INTRODUCTION AND BACKGROUND

MASSACHUSETTS 2002 BASELINE EMISSION INVENTORY OF:

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1. INTRODUCTION AND BACKGROUND

1.1 REGULATORY REQUIREMENTS

The federal Clean Air Act (CAA) and associated regulations require that states compile and submit to the U.S. Environmental Protection Agency (EPA) estimates of certain air pollutants emitted from sources within their borders. Areas that fail to attain one of more of the National Ambient Air Quality Standards (NAAQS)[1] must develop emission inventories as part of the State Implementation Plan (SIP) they submit to EPA demonstrating how they will attain the NAAQS. Inventories provide estimates of the contribution of various source categories to pollution levels and are important components of state plans to attain the NAAQS.

In June 2002, EPA promulgated new emission inventory requirements and consolidated other emissions reporting requirements in the Consolidated Emissions Reporting Rule (CERR) (67 Federal Register 39602). For the first time, the CERR requires that, irrespective of a state's NAAQS attainment status, it must develop and update every three years a single, statewide annual inventory of all pollutant emissions that contribute to regional haze.[2] The pollutants that contribute to regional haze are: volatile organic compounds (VOCs), nitrogen oxides (NOx), carbon monoxide (CO) particulate matter (PM), ammonia (NH3) and sulfur dioxide (SO2).

1.2 MASSACHUSETTS INVENTORIES

Prior Inventories

Massachusetts has developed multiple emission inventories since the 1980s. As a non-attainment area under the 1-hour ozone and the CO NAAQS, Massachusetts was required to develop a 1990 base year emission inventory for a typical summer day for VOCs, NOx and CO, and for a typical winter day for CO. Massachusetts was also required to conduct Periodic Emission Inventories (PEIs) to update the 1990 base year inventory for the years 1993, 1996 and 1999. (Additional information about these prior inventories is available at the Massachusetts Department of Environmental Protection (MassDEP) web site at: www.mass.gov/dep/bwp/daqc/daqcpubs.htm.) These inventories were used to meet regulatory requirements related to the 1-hour ozone and CO standards, to demonstrate progress in reducing emissions, to help plan for the adoption of control measures, and to track trends in emissions from various source categories.

Although not required by federal or state regulations, MassDEP has conducted an emission inventory of mercury, a limited inventory of dioxin and an inventory of a limited number of other toxic pollutants from a limited number of source categories. Inventory data related to these toxic pollutants are not included in this report.

[1] NAAQS are set for the six criteria pollutants: ozone, nitrogen dioxide, particulate matter, carbon monoxide, sulfur dioxide, and lead.

[2] In July 1999, EPA promulgated regulations (64 Federal Register 3714) that require states to reduce regional haze, which is caused by particulates (soot) and related gases (nitrogen dioxide and sulfur dioxide) that scatter and absorb light, diminishing visibility in Class 1 federal areas (certain parks and wilderness areas).

2002 Inventory
In 1997, EPA adopted the 8-hour ozone NAAQS.[3] In April 2004, EPA designated Massachusetts as non-attainment under the 8-hour ozone standard with a classification of "moderate" and with two non-attainment areas, Eastern and Western Massachusetts. (See Figure 1.1.) In 2007, Massachusetts is required to submit to EPA an 8-hour ozone standard SIP demonstrating how the two Massachusetts non-attainment areas will attain the standard by 2010. This SIP must contain emission inventories of the three precursors of ozone: VOCs, NOx, and CO.[4] This report will be part of that SIP submittal.

Massachusetts is in attainment of all of the other NAAQS so is not required to inventory any other pollutants to meet attainment SIP requirements. However, pursuant to the CERR requirements, this inventory also includes estimates of annual emissions of PM10, PM2.5, SO2, and NH3, all of which contribute to regional haze and PM concentrations.

1.3 USES OF EMISSION INVENTORIES

Different types of inventories are used for different regulatory and planning purposes. A **base year inventory** serves as a tool for measuring emissions reductions that take place subsequent to the base year. EPA has established 2002 as the base year for 8-hour ozone standard attainment planning.[5] States will measure their progress toward attainment from this base year inventory and be able to take credit in their attainment SIPs for reductions that occur subsequent to 2002, but before their attainment year.

EPA has also established 2002 as the base year for measuring progress towards long-range visibility goals under the regional haze program. Under the federal regional haze rule, EPA established five regional planning organizations (RPOs) to assess the impacts of different pollution sources on visibility. The Mid Atlantic Northeast Visibility Union (MANE-VU) is the RPO for the Mid-Atlantic and Northeast region.[6] MANE-VU is developing a multi-state 2002 base year emissions inventory for the MANE-VU region for regional haze planning and compliance purposes. As part of the development of this multi-state inventory, MANE-VU identified certain source categories where improvement in the available emissions inventory data was needed for the modeling that will be part of the states' regional haze compliance plans. MANE-VU hired a contractor, E.H. Pechan & Associates, Inc. (Pechan), to develop more accurate and complete data for these categories. MassDEP has adopted the Pechan emissions estimates for certain source categories, as noted in this report.

Three-year cycle inventories are now required under the CERR for all states, irrespective of their NAAQS attainment status. The CAA also requires that ozone non-attainment area inventories be updated periodically. Massachusetts conducted its periodic emission inventories in 1993, 1996 and 1999 pursuant to this CAA requirement. For its next updated inventory, MassDEP will use 2005 data to update this 2002 inventory in 2006-2007. That update will be useful in assessing progress towards attainment of the 8-hour standard by 2010.

Future-year inventories are developed to estimate emissions in a future milestone year. Projected emissions are derived from the application of growth factors to the base year inventory. For 8-hour ozone planning purposes, this 2002 baseline data will be used to estimate emissions in 2009, the year by which

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[3] As part of its implementation of the 8-hour ozone standard, EPA revoked the 1-hour standard in June 2005.
[4] VOC, NOx and CO are ozone "precursors," which chemically react in the presence of sunlight and warm temperatures to form ozone.
[5] *2002 Base Year Emission Inventory SIP Planning: 8-hr Ozone, PM2.5 and Regional Haze Programs*, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 18, 2002. (www.epa.gov/ttn/chief/eidocs/2002baseinven_102502new.pdf)
[6] MANE-VU members include Connecticut, Delaware, the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, the Penobscot Indian Nation, Rhode Island, the St. Regis Mohawk Tribe, and Vermont. Also participating as non-voting members are the U.S. Environmental Protection Agency, the National Park Service, the U.S. Fish and Wildlife Service, and the U.S. Forest Service.

Massachusetts as a moderate non-attainment area will be required to have achieved emissions reductions sufficient to allow it to attain the 8-hour standard by its 2010 attainment year.

To comply with the regional haze rule, states must project emissions for future years in order to demonstrate reasonable progress in achieving long-term visibility goals. MANE-VU will use the 2002 base year MANE-VU inventory to project future year inventories of regional haze pollutants in the MANE-VU regional haze planning area. Future year inventories will be developed for the regional haze milestone years of 2009, 2013 and 2018.

Modeling inventories are required to perform the modeling that will be part of the attainment demonstration SIPs that must be submitted for non-attainment areas. A modeling inventory is prepared for use in a specific modeling application and is used to measure the impact of different control measure scenarios in a particular year. This 2002 data will be used for the modeling that will be part of the Massachusetts ozone attainment demonstration SIP. It will also be used for regional haze modeling and planning along with state-specific inventory data submitted by each of the MANE-VU states.

1.4 INVENTORIED POLLUTANTS

Annual and Seasonal Emissions

Emissions inventories generally present estimates of annual emissions for a given year. Methodologies, including emission factors, correction factors and activity levels are developed to represent annual average conditions. (Annual emissions are shown as tons per year (TPY) in the data sections of this report.) In addition to annual emissions, estimates of emissions during a particular season are presented for certain pollutants.

In ozone non-attainment areas, because high ozone concentrations are generally associated with warmer weather and emissions from sources may vary seasonally, EPA requires that states estimate the ozone precursors emitted during the ozone season. The peak ozone season for Massachusetts is May through September, with most ozone exceedances occurring in the months of June, July and August. For Point and Area sources, seasonal activity data, if available for a source category, or an adjustment factor applied to annual data, are used for generating typical summer day emissions. For the Mobile Source categories, where temperature is an important factor in emission estimation, per EPA guidance, MassDEP used the average temperatures for the ten days with the highest ozone levels in the last three years (2000-2002) to generate the temperature factor used to estimate Mobile Source ozone season emissions. Ozone season emissions are reported for the ozone precursors, VOCs, NOx and CO, and are shown in the data sections of this report as tons per summer day (TPSD).

For CO non-attainment areas, EPA requires that the CO emissions inventory should reflect the conditions when peak CO concentrations occur. For most areas in the country, including Massachusetts, the peak CO season is in the winter months of December, January and February. Although Massachusetts no longer has CO non-attainment areas, it is continuing to report winter emissions of CO in order to track emission trends. In the data sections of this inventory, winter CO emissions are shown as tons per winter day (TPWD).

For the Area Source category of fuel combustion, because there are significant seasonal variations in emissions, MassDEP has incorporated data for the four seasons developed by Pechan for MANE-VU. For this category, in addition to annual, TPSD and TPWD emissions, tons per spring day (TPPD) and fall day (TPFD) are also reported.

Pollutants

This report estimates annual emissions of the following pollutants: VOCs, NOx, CO, SO2, PM10, PM2.5, and NH3. All emissions are estimated for the calendar year 2002. In addition, typical summer day emissions of the ozone precursors, VOCs, NOx and CO are estimated, typical winter day emissions of CO are

estimated. Tons per spring day (TPPD) and fall day (TPFD) are also estimated for Area Source fuel combustion.

A **VOC**, as defined in Massachusetts regulation 310 CMR 7.00, is any compound of carbon which participates in atmospheric chemical reactions. (Non-reactive VOC compounds excluded from this definition are referenced in the Stationary Point Source Section.) VOCs are emitted from industrial, commercial and residential solvent and fuel combustion processes, on-road and off-road mobile sources, and biogenic sources.

NOx is emitted from fuel combustion by on-road mobile, off-road mobile, industrial, commercial, and residential sources. Nitrogen dioxide (NO_2) is one of the major components of NOx. In addition to being a precursor to ozone, NO_2 is also a criteria pollutant and contributes to acid rain formation and regional haze. (Massachusetts is in attainment of the annual NO_2 NAAQS.)

CO is generally emitted from the same combustion processes that produce NOx. CO is a minor precursor to ozone formation and is also a criteria pollutant. The last remaining cities in Massachusetts to be in non-attainment of the CO standard were re-designated to attainment in 2002 and are now classified as CO "maintenance" areas. CO concentrations are highest during cold weather so typical winter day emissions are inventoried.

PM (particulate matter) is the mixture of tiny airborne particles in the air, including dust, dirt, soot, smoke, and liquid droplets. In this inventory, PM refers to "primary" PM -- particles that enter the atmosphere as a direct emission from a stack or other source. Secondary PM refers to particles that form through chemical reactions in the ambient air; secondary PM is not inventoried. Sources of primary PM include industrial processes, solvent operations, fuel combustion, incinerators, heat and power plants, and motor vehicles. Particulate matter is both a NAAQS and a contributor to regional haze.

PM10 refers to coarse particles equal to or smaller than 10 micrometers in diameter. **PM2.5** particles are less than or equal to 2.5 micrometers in diameter (or about one-thirtieth the diameter of an average human hair). PM10 and PM2.5 are both criteria pollutants and contributors to regional haze. This is the first time that DEP has conducted an inventory of these pollutants, which is required by the CERR.

Massachusetts is in attainment of the PM10 standard. In December 2004, EPA designated Massachusetts as an attainment area for PM 2.5.

NH3 (ammonia) is a precursor of PM2.5 and contributes to regional haze. NH3 emissions in Massachusetts are inventoried for the first time in this report pursuant to requirements of the CERR. NH3 is emitted from waste treatment facilities, wood-burning, animal wastes, fertilizers, soils, and mobile sources.

SO2 is a criteria pollutant as well as a contributor to regional haze and acid rain. (Massachusetts is in attainment of the SO2 NAAQS.) The CERR requires that states conduct an inventory of SO2. In addition, Massachusetts inventories SO2 emissions pursuant to the State Acid Rain Program requirements, 310 CMR 7.21. This state regulation requires that MassDEP report statewide SO2 emissions annually to determine whether a statutory cap and trigger level of SO2 emissions is exceeded.

1.5 INVENTORY GUIDANCE

EPA has developed a number of guidance documents to assist states in developing emissions inventories. Many of the guidance documents issued by EPA in prior years for the development of inventories under the 1-hour ozone standard continue to be applicable. In June 2003, EPA released new draft guidance, titled "Emission Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations" that defines elements of emission inventories

to meet SIP requirements for complying with the 8-hour ozone NAAQS, the revised PM NAAQS, and the regional haze regulations.

Other EPA guidance documents, such as those prepared by the Emission Inventory Improvement Program (EIIP)[7], have been relied on extensively in this report. The EIIP guidance documents include a set of "preferred and alternative methods" for inventory tasks that standardizes methodology thereby improving the consistency of collected data and increasing the usefulness of emissions information.

As with prior inventories, MassDEP has followed as closely as feasible EPA procedural guidance documents for the development of this 2002 base year emissions inventory. These primary inventory guidance documents are listed in the Reference section of this Introduction and Background Section and are also cited throughout the source category sections of the report as appropriate.

1.6 INVENTORY CATEGORIES AND METHODOLOGY

The general methodology used in developing the emission inventory for Stationary Point, Stationary Area, On-Road Mobile, Off-Road Mobile, and Biogenic sources involves the application of activity factors and emission factors to source categories. An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., pound of particulate emitted per ton of coal burned). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages of activities or operations in the source category. More detailed descriptions of the methodologies used to estimate emissions of particular types of sources are included in the various sections of this report.

Stationary Point Sources (Section 2). MassDEP includes in the Stationary Point Source categories large stationary facilities with actual emissions over 10 tons per year (TPY) of VOC and NOx and over 100 TPY of CO, SO2, PM10, PM2.5 or NH3. The Stationary Point Source data is derived from a source registration form mailed annually to Massachusetts factories, power plants, and other large business facilities. Facilities are required to report emissions to the ambient air of the inventoried pollutants and submit the form to MassDEP. MassDEP records the facility data in a database called the Stationary Source Emission Inventory System (SSEIS). The most common method for calculating point source emissions involves the use of emission factors in combination with activity factors. The activity factor is the quantity and type of material or fuel used. SSEIS has a built-in table of EPA emission factors that are based on source classification codes (SCC) related to the specific source process. A single facility may report emissions for multiple source processes. MassDEP factors in the facilities' control equipment and its estimated effectiveness when estimating emissions for these sources.

Data from source-specific emission tests or continuous emission monitors (CEMs) are usually preferred for estimating a stationary source's emissions because they provide the best representation of the tested source's emissions. However, test data from individual sources are not always available and, even then, they may not reflect the variability of actual emissions over time. Thus, emission factors are frequently the best or only method available for estimating emissions, in spite of their limitations. MassDEP incorporates in this inventory, emission data as reported to it on the source registration forms by facilities; this data may be derived from CEMs or from other methods. Additional information concerning the methodology for

[7] The EIIP is a joint program of the U.S. EPA and the State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials (STAPPA/ALAPCO). Additions and revisions to EIIP guidance documents are ongoing and the guidance does not currently address all categories within sectors.

estimating emissions from stationary point sources can be found in Section 2.3 - Methodology: Emission Estimation Procedures.

Stationary Area Sources (Section 3). Area sources collectively represent individual sources that are small and numerous, and that have not been inventoried as specific point, mobile, or biogenic sources. These individual sources are grouped with other like sources into an area source category. Their emissions can then be estimated collectively using one methodology. For example, gasoline stations and dry cleaning establishments are treated as area sources. The main reason not to treat them as point sources is that the effort required to gather data and estimate emissions for each individual facility is great while emissions per facility are generally small.

An annual emissions threshold distinguishes stationary point and stationary area sources. The thresholds for stationary point sources, as noted above, are 10 tons per year (TPY) of VOC and NOx and 100 TPY of CO, SO2, PM10, PM2.5 and NH3. If emissions from a stationary point source are below these thresholds, the source will be inventoried as a stationary area source.

There are also categories of area sources, such as pesticides and commercial/consumer products, which generate emissions but are not emitted from a facility. These types of non-facility specific area sources are also included within the Stationary Area Source categories of this inventory.

The Stationary Area Source section is comprised of six categories: 1. waste management practices; 2. gasoline distribution; 3. solvent use; 4. combustion processes; 5. agricultural activities; and 6. fugitive dust from construction and paved/unpaved roads.

Point sources are inventoried individually; area sources are inventoried collectively based on an estimated level of activity related to a particular type of area source. The activity factors for these area sources include material sales records, state registration records, fuel/material usage, default employment, and per capita data. MassDEP obtained emission factors from EPA's *Compilation of Air Pollution Emission Factors*[8] ("AP-42") and the Emissions Inventory Improvement Project guidance documents. Several source categories were estimated based on state employment and population data. Area source emissions were apportioned to counties based on available fuel/material used, employment, state registration, and population data. For the area source categories of wood-burning, open burning, and paved and unpaved roads, MassDEP used emission estimates developed for MANE-VU by a contractor who conducted extensive regional surveys to assess activity levels associated with these categories.

MassDEP applies a rule effectiveness formula[9] to those area source categories that are subject to state regulatory controls (e.g., gasoline station stage I tank truck unloading).

On-Road Mobile Sources (Section 4) include emissions from roadway and highway vehicles, such as cars, trucks, and buses. The Massachusetts Highway Department (MHD) developed the activity factor, which is daily vehicle miles traveled (DVMT). EPA's current model for mobile emissions estimates, MOBILE6.2, requires a wide range of state input parameters such as vehicle Inspection and Maintenance program (I/M) data, temperature, vehicle mix, vehicle age distribution, and mileage accumulation rates. I/M inputs include start year, anti-tampering rates, and emission failure rates. MOBILE6.2 calculates emission factors for all vehicle types for speeds up to 65 mph. MassDEP multiplied the DVMT by the MOBILE6.2 emission factors according to roadway type and speeds in order to calculate on-road mobile emissions by county for a typical summer day for ozone precursors and for a typical winter day for CO. For annual emissions, MassDEP used the emissions for all

[8] *Compilation of Air Pollutant Emission Factors, Volume. 1, Stationary Point and Area Sources,* AP-42, Fifth Edition and Supplements, U.S. Environmental Protection Agency, Research Triangle Park, NC, 1997. (www.epa.gov/ttn/chief/publications.html#factor)

[9] Rule effectiveness reflects the ability of a regulatory program to achieve some percentage of all the emission reductions that could be achieved with full compliance by all sources at all times.

pollutants estimated by Pechan for MANE-VU. The Pechan data was based on twelve separate monthly MOBILE 6.2 runs, which MassDEP did not have the resources to perform.

Off-Road Mobile Sources (Section 5) include emission estimates from various types of engines used in construction equipment, locomotives, lawn and garden equipment, and numerous other types of off-road mobile operations. The basic activity factor is the number of various engines and the quantity of different types of fuel multiplied by appropriate emission factors. MassDEP used the latest Version NONROAD2005a (Feb. 2006) computer model developed by EPA Office of Mobile Sources to generate off-road emissions. Estimates were developed for a typical summer day for ozone precursors and for a typical winter day for CO. For annual emissions, MassDEP used the emissions for all pollutants estimated by Pechan for MANE-VU. The Pechan data was based on twelve separate monthly runs of the NONROAD model, which MassDEP did not have the resources to perform.

Biogenic Sources (Section 6) are natural, biological sources of ozone precursor emissions such as trees, agricultural crops, or microbial activity in soils or water. This reports includes biogenic emissions estimated by EPA using its Biogenic Estimation Inventory System (BEIS-3) model and reported in EPA's 2002 National Emission Inventory (NEI).[10] The model incorporates EPA's default land use, crop acreage, and forest type by county, and assigns emission rates to different land use types. It applies meteorological data inputs, including temperature and insulation for a typical summer day. Earlier biogenic emission models estimated VOC emissions only, whereas BEIS-3 now estimates a small amount of NOx and CO. MassDEP has used EPA's estimate for this category because it does not have better quality emissions data than what EPA has developed.

1.7 2002 EMISSIONS SUMMARIES

Tables 1.1 and Figures 1.2 to 1.10 present summaries of the inventoried pollutants broken out into the five source categories of point, area, mobile on-road, mobile off-road and biogenics. VOC, NOx and CO emissions are shown with and without biogenic emissions. VOC, NOx and CO, because they are ozone precursors, are reported in tons per summer day (TPSD) and in tons per year (TPY); only tons per year (TPY) emissions are reported for the other pollutants. CO is also reported in tons per winter day (TPWD).

Tables 1.2 and 1.3 list detailed source types by Source Classification Code (SCC) within the five major source categories. Table 1.4 lists the top ten contributors to VOC and NOx emissions by source type. Table 1.5 lists the top ten contributors of combined VOC and NOx emissions by source type.

1.8 EMISSION TRENDS 1990 TO 2002

From 1990-2002, DEP has estimated emissions for four pollutants – VOC, NOx, CO and SO2. This allows DEP to track trends in the emissions of these pollutants. Emissions of PM10, PM2.5 and NH3 are inventoried for the first time in this report so no emission trends for these pollutants are available.

These trends data demonstrate the success of various control strategies implemented as part of the 1-hour ozone attainment plan and pursuant to the Massachusetts Acid Rain Program requirements. For example, emissions from point sources have declined significantly partly as a result of emissions control requirements for large facilities such as power plants and factories. Emissions from on-road mobile sources have also

[10] EPA's National Emissions Inventory (NEI) is a national emissions inventory database that incorporates emissions data received from a variety of sources into a comprehensive national inventory for the criteria pollutants and 188 hazardous air pollutants. It is updated every three years. EPA released a February 2006 final version of the 2002 NEI data that include state and county estimates for 7 criteria pollutants and 188 HAPS. States may adopt NEI data into their state inventory. The NEI can be accessed at: www.epa.gov/ttn/chief/net/2002inventory.html.

declined significantly despite the increase in vehicle miles traveled during this period due to a variety of programs including federal engine standards, cleaner gasoline (RFG) and the Massachusetts Enhanced Vehicle Inspection and Maintenance Program (MA I/M program).

While these trends data demonstrate substantial reductions in emissions since 1990, additional reductions will be needed prior to 2010 in order to demonstrate attainment with the 8-hour ozone standard. For purposes of demonstrating attainment of the 8-hour ozone standard by 2010, emissions reductions that occurred in Massachusetts in years prior to 2002 are not creditable; the Massachusetts 8-hour ozone attainment demonstration SIP will need to demonstrate the reductions in ozone precursors that will take place subsequent to 2002.

Table 1.6 and Figures 1.11 to 1.14 present annual emission trends from 1990 through 2002 for each of the years for which an inventory was completed. In order to try and compare emissions trends over time, MassDEP ran the latest MOBILE6.2 and NONROAD2005a models for all the earlier years so that the data is more comparable throughout this period and more accurately reflects annual emission trends.

While emissions inventory data can illustrate trends in emissions over time, the methodologies and emissions factors used to calculate emissions change as EPA and MassDEP improve the emission inventory process. Therefore, emissions estimates in different inventories are not always fully comparable.

VOC

Total VOC emissions were reduced by 342 TPSD or 33% from 1990 to 2002, with 205 tons of those reductions attributable to on-road mobile sources. The on-road mobile source emission reductions for this period, in spite of increased Vehicle Miles Traveled, are due to the ongoing numerous programs to reduce emissions from motor vehicles, including: the Federal Motor Vehicle Control Program (FMVCP), Massachusetts Low Emission Vehicle program (LEV), Massachusetts Enhanced Inspection and Maintenance (MA I/M) program, Stage II Vapor Recovery for Gasoline Stations, and Reformulated Gasoline (RFG).

NOx

Total NOx emissions decreased by 145 TPSD or 16% from 1990 to 2002. Point source reductions of 188 TPSD are attributable to the Reasonably Available Control Technology (RACT) program and reductions in power plant emissions. Although overall NOx emissions increased slightly by 2 TPSD from on-road mobile sources from 1990 to 2002, the reduction from 1999 to 2002 was 19%, reversing the trend of increasing emissions for this category from 1990-1999. This reduction is attributable to the MA I/M and LEV programs. NOx emissions from on-road vehicles are expected to further decrease after 2002 as older, higher emitting cars are replaced with cleaner vehicles. Off-road emissions increased by approximately 36 TPSD during this period. Newly adopted control programs are expected to reduce NOx emissions from this category subsequent to 2002.

CO

Total CO emissions decreased by 2,209 TPSD or 34% from 1990 to 2002. Despite slight increases in emissions from area and off-road categories, the overall reduction is attributable to an estimated 2,549 TPSD (54%) reduction in on-road mobile emissions for this period. Future reductions from off-road engines are expected as programs to control emissions from these sources are implemented.

SO2

Total SO2 emissions decreased by 235,097 TPY or 64% from 1990 to 2002, with 173,362 TPY of these reductions due to controls on point sources, mainly power plants. Table 1.7 is a comparison of the annual emission levels and the state statutory cap and trigger levels since 1979. This table shows that because of substantial emission reductions, emissions for 2002 are now less than half of the Massachusetts statutory cap and trigger levels.

Other Pollutants
There are no trend data for PM10, PM2.5 and NH3 because these pollutants are inventoried for the first time in this report.

1.9 INVENTORY REVIEW PROCESS

MassDEP will issue this draft 2002 Baseline Emissions Inventory for a 30-day public review and comment period as part of its 8-hour Ozone Attainment State Implementation Plan (SIP). The Attainment SIP is required to be submitted to EPA by June 15, 2007. A public hearing will be held following the close of the 30-day period. MassDEP will respond to comments received on the Attainment SIP, including this inventory and make revisions as appropriate based on comments received. MassDEP may also make revisions based on any new information or data that becomes available to MassDEP.

1.10 QUALITY ASSURANCE PROCEDURES

In this 2002 inventory, MassDEP used quality assurance (QA) procedures that were developed by an independent contractor in connection with the Massachusetts 1990 base year inventory. (The contractor's QA Report was included in the Massachusetts 1990 inventory.) The QA procedures have two levels of review. Level I is a checklist that includes minimum requirements of EPA's inventory guidance such as establishment of non-attainment areas and their classification, pollutants covered and their source categories, and use of the latest EPA emission models such as MOBILE6.2 and NONROAD2005a. Level II is a more detailed checklist that includes: ensuring that point sources are reported down to appropriate thresholds; "reality checks" such as converting category emissions on a per capita basis compared to EPA national expected ranges; proper application of Control efficiency/Rule effectiveness/Rule penetration; and prevention of double counting between point and area sources. All of these procedures were employed in development of this inventory.

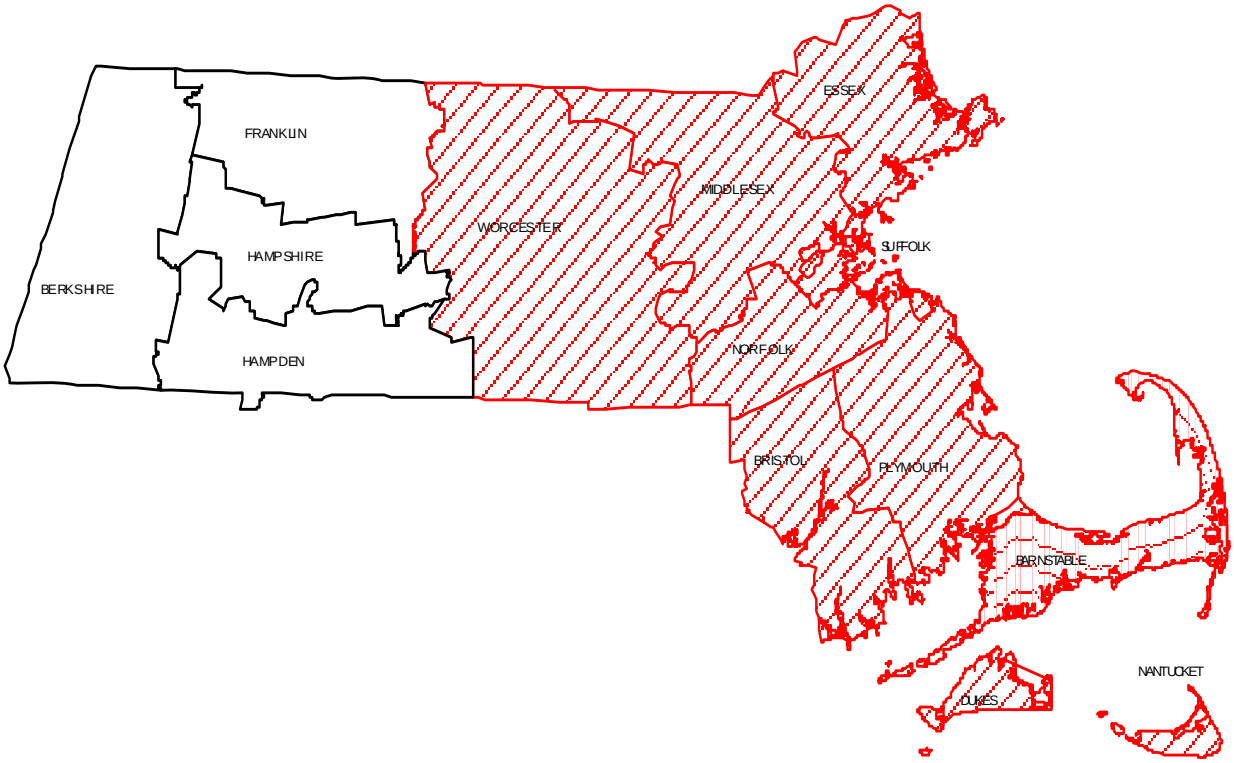
All emissions were developed using Excel spreadsheets with built-in QA mechanisms. Emissions were given a 'reality check' using manual calculations. A preliminary draft was reviewed internally and revisions were made based on comments received to enhance the accuracy of emissions.

As noted in various sections of the narrative, data used in the inventory for a number of categories was in whole, or in part, developed by several external parties such as EPA, Carnegie-Mellon University (CMU) and EH Pechan. Their data was checked for accuracy by MassDEP before being included in this inventory. In addition, many of the categories have been reviewed as part of the MANE-VU inventory development process providing a cross-check of the data provided by one state versus another state within the MANE-VU region as well as providing a cross-check of the data provided by EPA, consultants and the states themselves.

MassDEP used emissions from EPA's NEI for Biogenics developed from the BEIS-3 model. CMU prepared the Ammonia emissions from livestock and other animals. MANE-VU contractor EH Pechan developed emissions using multi-state surveys for categories such as Open Burning and Wood Burning. EH Pechan also developed annual emissions for On-Road/Nonroad Mobile and Paved/Unpaved Roads. Emissions were prepared for and reviewed by multiple states, including Massachusetts, making the emissions for these categories consistent with other MANE-VU states.

FIGURE 1.1

MASSACHUSETTS COUNTIES AND 8-HOUR OZONE STANDARD NON-ATTAINMENT AREAS



Counties in Eastern Massachusetts 8-Hour Ozone Non-Attainment Area

Barnstable	Nantucket
Bristol	Norfolk
Dukes	Plymouth
Essex	Suffolk
Middlesex	Worcester

Counties in Western Massachusetts 8-Hour Ozone Non-Attainment Area

Berkshire	Franklin
Hampden	Hampshire

GENERAL REFERENCES FOR MATERIALS USED
IN 2002 BASELINE EMISSIONS INVENTORY DEVELOPMENT

2002 Base Year Emission Inventory SIP Planning: 8-hr Ozone, PM2.5 and Regional Haze Programs, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 18, 2002. http://www.epa.gov/ttn/chief/eidocs/2002baseinven_102502new.pdf

Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations. EPA-454/R-99-006.

Emission Inventory Improvement Program, Volumes 1-7, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1997. http://www.epa.gov/ttn/chief/eiip/techreport/volume01/index.html

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Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources, U.S. Environmental Protection Agency, Office of Mobile Sources and Office of Air Quality Planning and Standards, EPA 420/R-92-009. December 1992. http://www.epa.gov/otaq/invntory/r92009.pdf

Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone - Volume I; General Guidance for Stationary Sources. EPA-450/4-91-016, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1991.

Guidelines for Estimating and Applying Rule Effectiveness for Ozone/CO State Implementation Plan Base Year Inventories, EPA-452/R-92-010, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1992. http://www.epa.gov/ttn/chief/old/eidocs/454r92010_nov1992.pdf

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